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*Cellular  
Cement*

## COMPLETE SPECIFICATION.

**"Improvements in porous or cellular cements and methods of making the same."**

I, JOHN AINSWORTH RICE, of 1165 Arch Street, Berkeley, in the State of California, United States of America, Chemical Engineer, a citizen of the United States of America, hereby declare this invention, and the manner in which it is to be performed, to be fully described and ascertained in and by the following statement:

The invention relates to porous or cellular cement and to methods of making the same, and in the present specification the word "cement" is used broadly to include mortar, grout, concrete, plaster, or any such material which hardens or sets when it dries. 15 The purpose of the invention is to provide a cementitious material which when set will contain a number of voids or spaces, whereby the material will be light but structurally strong and fireproof, and will effectively insulate sound and heat. This cement may be preferred in slabs or blocks, or may be laid down by pouring and allowed to set in situ. 20

The invention resides in cementitious material containing voids or cells, produced by a foam or lather stirred into the cement. Proposals for the production of porous cementitious material have hitherto been made in which foam or a foam producing substance is added to the cement mixing fluid. The foam producing substance has 30

consisted of mucilage (tangin) or soluble soaps such as resin-soda or resin-potash soaps, and additions of gelatine and formaldehyde have been proposed to increase the durability of the foam. 5

According to the present invention a foam-assisting agent consisting of an unsaponified resinous material dissolved in an organic solvent such as alcohol or acetone is added to a colloidal solution of a foam-producing agent containing a proteid material as its essential constituent, and a gas is incorporated into the solution to produce a foam which is added to the cement. Various substances can be used as foam-producing 15 agents, including gelatinous substances, and apparently any protein substances in colloidal solution will serve to make the foam. Egg albumen, blood albumen and casein are specially suitable. The foam-assisting agent preferably consists of rosin dissolved in alcohol or acetone, with sufficient formalin (40% formaldehyde) added to cause the resin to disperse when added to an aqueous liquid. The precipitate of resin remains in suspension and when the solution is beaten to a froth, the resin becomes a part of the walls of the bubbles, protecting and strengthening them and acting as a foaming agent before the bubbles are formed, in that it lowers the 25 surface tension of the liquid and adds to its 30

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viscosity. Other resins, such as copal bakelite varnish, and also such materials as cellulose and rubber, may be used instead of rosin. For the foaming agent the following 5 formaline may be used:—

	(i)	(ii)
Rosin	20 grams.	100 grams.
Acetone	50 cubic centi-metres	—
10 Alcohol	—	335 cubic centi-meters.
Formalin	34.5 cubic centi-meters.	181 cubic centi-meters.

The proportions of acetone and formalin 15 or of alcohol or other solvent and formalin must be carefully balanced both as regards each other and as regards the amount of resin. The resin should be dissolved in the solvent and the formalin should be added 20 in small portions, bit by bit, the mixing container being meanwhile shaken, until the solution becomes slightly cloudy. It may be tested by dropping a drop or two into clear water. If the solution emulsifies at once 25 and spreads all through the water, forming a milky dispersed precipitate, the proportion of resin to solvent and to the formalin is correct. If the precipitate does not mix with the water, more formalin or more solvent 30 should be added drop by drop. Maximum diffusibility is indicated by the precipitate diffusing through the water without clotting.

The foaming agent described above is to be mixed as follows to make a lather:—

35	Foaming agent	..	0.10%
	Gelatine or glue	..	0.15%
	Water	..	99.75%

These proportions may vary widely, but it is desirable to use as much water as possible 40 so that the other materials will not interfere with the setting of the cement.

Although the described foaming agent is preferred, glycerole may be used about as follows:—

45	Water	..	98.5%
	Gelatine	..	1.0%
	Glycerole	..	0.5%
	or		
	Water	..	98.3%
50	Gelatine	..	1.0%
	Formalin	..	0.2%
	Glycerole	..	0.5%

Successful experiments have been made with Spanish Bark usually known as soap

bark, a well known glucoside. The glucoside (1 part) is steeped into 99 parts of water for twenty minutes and the resultant liquor can be easily beaten into a stiff froth, mixing successfully with cement. Other 5 glucosides and saponines may be used, viz. yucca of several varieties, the aloe plant, a local soap root which in appearance resembles an onion and the roots of the senega plant. Solutions from these glucosides may 10 be used alone or mixed with a gelatinous solution, for more efficient foaming. As a further foaming agent, phenol may be mentioned, which tends to stiffen the froth when added to a solution of gelatine, and which 15 also seems to prevent breaking of the bubbles when mixed with strongly alkaline cements. Phenol is also a preservative for the gelatine solution, and phenol derivatives, among them lysol may be used. The effect 20 of phenol or a phenol derivative upon the setting of Portland cement, is quite marked and very beneficial, counteracting the tendency of the glue to delay setting of the cement. The following formula may be 25 used in this connection.

Gelatine	..	..	0.25%
Phenol	..	..	0.12%
Formalin	..	..	0.12%
Solution (1% of glucoside)	..	..	0.25%
Water	..	..	99.25%

The vapor of chloroform markedly stabilizes the foam and renders it more insoluble in water or in the cement mixture. Chloroform may be sprayed into the beating chamber before the solution is beaten, so that the lather is made in an atmosphere of chloroform vapor. A foam made in this manner can be washed with water before being used in making the cement, whereby 40 any excess of soluble gelatine is removed. Apparently the chloroform hardens the walls of the bubbles by toughening the films so that they do not easily break or dissolve in alkaline cements.

Different methods may be used for mixing gas into the solution to produce the foam or lather. For instance air may be introduced under pressure in the bottom of the tank containing the solution, and strained 50 through a suitable filter.

The following are examples of other mixtures for producing the foam.

Example 1. 4 volumes of formalin are added to 1,000 volumes of a 2% glue solu- 55

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coside. The glucoside into 99 parts of s and the resultant n into a stiff froth, h cement. Other may be used, viz. the amole plant. In appearance re-roots of the senegu these glucosides may 10 with a gelatinous ut foaming. As a phenol may be men- 15 ten the froth when elatine, and which making of the bub- strongly alkaline a preservative for phenol derivatives, is used. The effect 20 erivative upon the it, quite marked it, setting of the formula may be 25

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.. 0.13%  
.. 0.13%  
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.. 99.25%

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be used for mixing produce the foam air may be intro- the bottom of the ion, and strained 50

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of formalin are a 2% glue solu- 55

tion. Separately a solution of rosin and formalin is made as follows:

(A) 100 weight parts of resin.  
335 weight parts of alcohol  
18 weight parts of formalin (40% formaldehyde)  
or  
(B) 20 parts of rosin  
16 parts of acetone  
34 parts of formalin.

About 6 parts of the solution A or B should be added to 100 parts (by volume) of the glue solution. The rosin solution should be added while violently agitating the glue solution to insure immediate dispersion or dilution of the rosin solution. The mixture is then beaten to produce a foamy body. In place of rosin and the several substitutes therefor already mentioned, cellulose acetate, soluble phenol formaldehyde, or rubber may be advantageously used.

Example 2. 1 part of finely powdered common rosin is mixed with 16 parts of water and while agitated, enough ammonia water or other alkali is added to dissolve the rosin. This solution may be added to the glue solution as above described, using about 1 part of the rosin solution to 15 or 20 parts of the glue solution. In both the examples just described the strength of the glue solution may be varied for while a 2% solution is described, various concentrates, say from 0.1% to 10.0% can be used, and there are various substitutes for the glue, including gelatine, casein, albumen, solutions of various soluble adhesives such as dextrine, molasses, glucose, syrup, gum tragacanth and starch (boiled in water).

Example 3. A solution of a cellulose derivative such as cellulose acetate in acetone is added to a solution of casein in alkali, say 1 weight part of 6% solution of cellulose acetate in acetone to a solution of 4 weight parts of casein 1,000 weight part of water (containing sufficient alkali such as ammonia to dissolve the casein). This solution is converted into a foam directly, or after adding 1/250 weight part of formalin. Soap bark, common soap, rosin soap or the like may be added to make the mixture foam more strongly.

Example 4. 1 weight part of very thick viscose is added to 400 weight parts of a 2% solution of glue and water, or of a 1% solution of casein in alkaline water. This

mixture may be converted into foam directly, but preferably with rosin soap, soap or soap bark. Formalin may be added if desired.

Example 5. To the solution given in example 4 or to a plain solution of viscose containing about 0.02% cellulose are added 40 parts of a rosin solution consisting of 60 parts of water and 1 part of powdered rosin. While stirring, sufficient ammonia water is 10 added to dissolve the rosin. Then a sufficient amount of a weak solution (say 5%) of aluminium chloride, aluminium sulphate, a ferric salt, or an acid such as sulphuric or hydrochloric, or other suitable precipitant, is added to precipitate about from 4/5 to 9/10 of the rosin as resinate or a fine precipitate of rosin acids. The precipitate tends to produce a stable and tenacious foam and the precipitant improves the setting of 20 Portland cement by preventing or greatly impeding chemical reaction between the cement and the soluble resinates.

Example 6. 4 parts of starch and 100 parts of water are stirred and boiled, and 25 cooled. Separately, 1 part of finely powdered rosin is added to 30 parts of water containing ammonia water to dissolve the rosin (if desired, partially neutralizing with alum or the like). The two solutions are 30 mixed, and diluted with five times their volume of water, and beaten into a foam.

Example 7. Sulphuric acid is added to the resinate solution, to neutralize it, forming a colloidal suspension of resin acids. 35 In the present example and example 6, sulphuric acid may be used in sufficient quantity to produce a slow reddening of litmus paper.

Example 8. A lather is made according 40 to any of the foregoing examples, say with glue and formalin, and to about 5 cubic feet of the lather are added about 20 cubic centimeters of a 50% solution of calcium chloride ( $\text{CaCl}_2$ ). This mixture is then incorporated 45 with the cement grout.

In all the examples where a soap (say a resinate) or a solution of a resinous body (say shellac, rosin, etc. in alcohol or other solvent) or other foam-assisting body is 50 used, the amount of that constituent should be sufficient to reduce greatly the surface tension of the liquid, whereby it will foam better.

Having now fully described and ascer- 55 tained my said invention, and the manner

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in which it is to be performed, I declare  
that what I claim is:—

1. A method of making a porous cement  
product characterized by the fact that a  
5 foam-assisting agent, consisting of an un-  
saponified resinous material dissolved in an  
organic solvent such as alcohol or acetone,  
is added to a colloidal solution of a foam-  
producing agent containing a proteid mate-  
10 rial as its essential constituent, and a gas  
is incorporated into such solution to produce  
a foam which is added to a cement grout.

2. A method according to Claim 1, charac-  
terized by the fact that a small amount of  
15 the rosin is used in relation to a much  
larger amount of the proteid material.

3. A method according to either Claim  
1 and 2, and wherein rosin is the resinous  
material used, and a dispersing agent such  
20 as formalin is added to the resinous solution  
in amount substantially less than the amount  
of rosin, whereby the formalin modifies the  
action of the rosin.

4. A method according to Claims 1, 2 or  
3, in which the foam is produced by agita-  
tion of the resinous solution and the solution  
of the foam-producing agent in the presence  
of chloroform vapor.

5. A method according to either Claim 1  
or 2, wherein the resinous material consists  
of rosin, shellac, copal or soluble phenol-  
formaldehyde with or without the addition  
of rubber, celluloid, cellulose acetate or vis-  
cose together with the dissolved proteid sub-  
stance such as albumen, gelatine or glue.

6. A method according to any of the pre-  
ceding claims, in which the colloidal pro-  
teid solution contains ammonia.

7. The improved method of making  
cementitious material substantially as herein  
described.

Dated this 21st day of September, A.D.  
1926.

ANTHONY J. CALLINAN,  
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Witness—James H. Anderson.